NISTIR 6527

Measurement Needs for Fire Safety: Proceedings of an International Workshop

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U.S. Department of Commerce
William M. Daley, Secretary

Technology Administration
Dr. Cheryl L. Shavers, Under Secretary of Commerce for Technology

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Experimental Data for CFD Models

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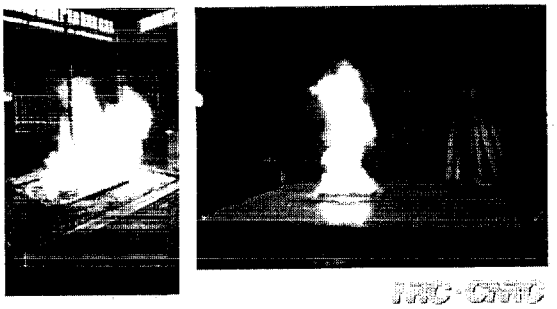
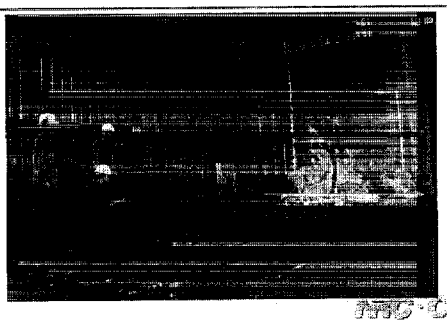
Outline

- Introduction
- CFD model description
- Input data needed
- Data for model validation
- Summary

Fires

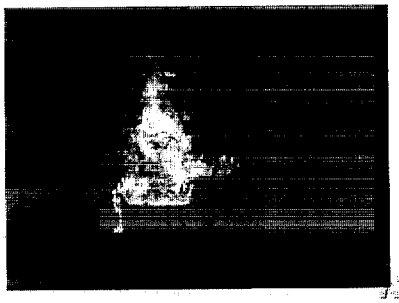


Fires



Sofa Burn

Sofa Burn



Sofa Burn

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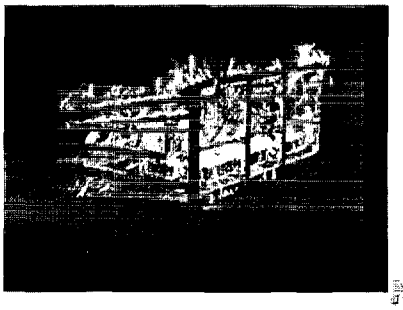
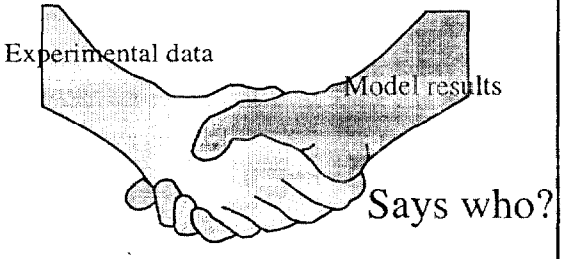


Good Agreement



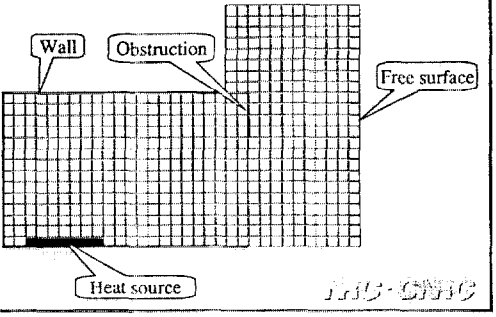
Computation vs Experiment

- "The only one who believes the numerical results is the author"
- "Everyone believes the experimental results except the experimentalist"

CFD Models

- Divide space into very small control volumes
- Solve the fundamental equations for mass, momentum energy and species concentration for each control volume

CFD Model - Grid



CFD Model Inputs

- Geometry of space/compartment
- Openings, obstacles
- Grid distribution
- Solution variables
- Boundary conditions
- Fire representation

Input data - Geometry

- Compartment dimensions
- Partitions
- Obstacles
- Openings

Input Data - Initial Conditions

- Temperature distribution in solution domain
- Air movements
  - Heat sources
  - Openings, wind effects
  - Stack effect

Input Data - Boundary Conditions

- Velocity
  - openings
  - leakage areas
  - surface roughness
- Energy
  - Thermal properties of boundaries
  - radiative properties
- Dynamic changes to boundary conditions
  - Doors windows open during test
  - fire size changes during test
  - forced ventilation activates during test

Input data - Fire

- Heat release rate vs time
- Yield fractions for CO, CO_2, and other toxic gases
  - representative of fuel and scenarios considered
  - yield data usually from bench tests
- Ideal if productions are per unit mass
- Location of fire
  - area
  - height
  - plume characteristics

Combustion modelling

- Type of fuel, thermal, thermodynamic and combustion properties
- Rate of release of fuel into domain
  - input
  - calculated - very difficult for furniture

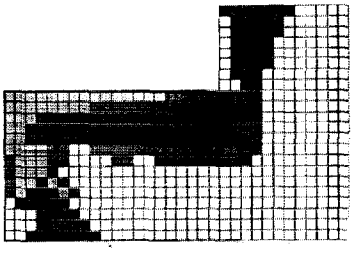
Input data - Detection Systems

- Location
- Characteristics
  - RTI
  - rate of temperature rise

Input data - Mechanical Ventilation

- Location and area of inlets/outlets
- Flow rates
- Properties ambient air
- Time of activation

CFD Model Results



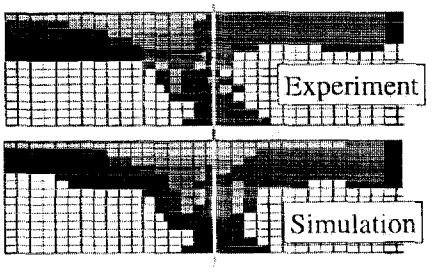
Direct Output Data

- Temperatures
- Velocities
- Concentration of toxic gases
- Radiation fluxes
  - Not economical to get adequate data especially for large compartments

Indirect Output Data

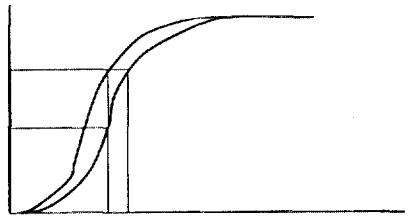
- Fire heat release rates
- Upper layer properties: temperature, CO, CO_2
- Upper layer height
- Plume entrainment rates
- Flows through openings

One to One Comparisons



Modelling Dynamic Events

- Time of activation vs conditions for activation



Needed for CFD Models

- Compartment characteristics
- Initial conditions
- Dynamic conditions
- Fire characteristics
- Temperature, CO, CO_2 distributions vs time
- Flow rates